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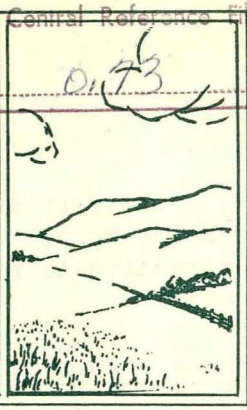

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RECENT DIRECT SEEDING TRIALS IN THE PINE REGION OF CALIFORNIA

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Direct seeding is a highly desirable method of regeneration. It is more economical and more flexible in both time and place than the planting of trees. In California, however, direct seeding generally has been an ineffective method of regeneration. Early trials by the Forest Service[1] with broadcast sowing and spot sowing invariably failed to produce an adequate stand of reproduction, primarily because forest rodents destroyed the seed or seedlings. Poisoning and trapping had little effect. Protecting seed spots with screens was judged to be effective but not economical. More recently, direct seeding, both broadcast and spot sowing, has been tried on large burns in a gamble to increase the area reforested beyond that possible by planting. Only rarely was the gamble successful and the circumstances attending the success are not known.

Nevertheless, interest in direct seeding has not diminished. A number of experiments, large and small, have been conducted in the hope that some device, procedure, or condition might be found to make the practice more successful. Many of these experiments were concerned directly or indirectly with the problem of controlling rodents, the primary obstacle to direct seeding. Others were concerned with seedbed condition and with seed treatment. In some tests the relative effectiveness of direct seeding and of planting was compared. All these experiments were tests of spot sowing, not broadcast sowing. This report summarizes these trials for those persons interested in direct seeding as a practical means of regeneration and for those interested in a background for trials of their own.

1/ Show, S. B. 1930. Forest nursery and planting practice in the California pine region. U.S.D.A. Circular 92, 75 pp.

* MAINTAINED AT BERKELEY, CALIFORNIA, IN COOPERATION WITH THE UNIVERSITY OF CALIFORNIA.

Agriculture-- Berkeley

Trials of Controlling Rodents

The depredations of rodents may be prevented by several means: (1) Reducing or removing the rodent populations, (2) making the seed unattractive to rodents, and (3) mechanically protecting the seed from rodents.

Broadcast Poisoning

One of the common procedures for reducing the rodent populations is to distribute poison baits on the area to be regenerated and on a surrounding buffer strip before the seed is sown. Measured in terms of the success of the seeding, the effectiveness of this procedure has been variable. In the northern Rocky Mountain region Schopmeyer[2/] and Helmers concluded that broadcast poisoning with thallium-treated sunflower seeds a week before seeding gave good rodent control. Results in some other regions have not been so promising.[3/] Two tests in the California region did not result in satisfactory rodent control.

One of these tests was part of a natural regeneration experiment on the Stanislaus Experimentsl Forest in 1948. The poison bait used was oat groats treated at the rate of 3 ounces of "1080" (sodium fluoroacetate) per 100 pounds of groats. This bait was distributed in July on about 600 acres at the rate of 1/2 to 2/3 pounds per acre. To measure the effectiveness of the rodent control, 400 screened and 400 unscreened seed spots, each with 5 seeds per spot, were put out in the fall of 1948. In September 1949, 38 percent of the screened spots and 16.5 percent of the unscreened spots had one or more seedlings per spot. Many of the unscreened spots and some of the screened spots were disturbed by rodents.

From rodent trapping data[4/] in the test it appears that the rodent population was temporarily reduced but built up during the fall and winter. In late September 1948, before seedfall, only one chipmunk (Eutamias sp.) was caught in 120 trap nights. In June 1949, 35 acres of the area being regenerated was treated with 5 pounds of poisoned sugar pine seed. Each seed carried about 12 milligrams of "1080", an extremely toxic dosage. Two weeks after this second baiting 8 mice (Peromyscus sp.) and 1 chipmunk were caught in 200 trap nights.

2/ Schopmeyer, C. S. and A. E. Helmers. 1947. Seeding as a means of reforestation in the northern Rocky Mountain region. U.S.D.A. Circular 772, 31 pp. illus.

3/ Huberman, M. A. 1940. Experimental direct seeding by the Forest Service. Issued by Division of Forest Management Research, U. S. Forest Service, Washington, D. C. 57 pp. processed.

4/ These observations were made in cooperation with Joseph Keyes, U. S. Fish and Wildlife Service, and Dr. E. W. Jameson, University of California.

The other test was made in the Stanislaus National Forest in 1934. Preparatory to a planting and seeding trial, the area to be seeded and a surrounding buffer strip were treated with grain carrying strychnine. First-year establishment of seedlings indicates that the rodent control measures were not sufficiently effective. The percent of seed spots with one or more seedlings was:

Species	Spots screened	Spots unscreened
Ponderosa pine	51	6
Sugar pine	58	6
White fir	8	2

Burning

Burning often has been suggested as a means of reducing the rodent population. Although burning with only this objective has not been tried, two seed-spotting trials in burns indicate the possible results. A very hot fire occurred in Anderson Valley on the Stanislaus National Forest in late July 1934. That fall a group of screened and unscreened seed spots were put in the burn. Although better germination and survival occurred on the screened spots (table 1), regeneration would have been possible without the screen protection. The rather high germination and survival rate in the unscreened spots indicates a small amount of disturbance by rodents. It is not known whether the light disturbance resulted from a reduced population of rodents or from the heavy seed crop present on trees surviving the fire--more than enough seed to satisfy the appetite of a normal rodent population.

Table 1.--Germination and first-year survival of screened and unscreened seed spots in Anderson Valley, 1935

Species	Protection	Number spots	Germination	Survival
			Percent 1/	Percent 1/
Ponderosa pine	none	1660	83	67
	screens	340	91	83
Sugar pine	none	160	59	44
	screens	40	85	78
Jeffrey pine	none	160	82	75
	screens	40	98	90
White fir	none	160	81	59
	screens	40	95	88

1/ Percent of seed spots with one or more seedlings.

On the other hand fire apparently had little effect on rodents in a brushfield planting trial at Burney Springs, Lassen National Forest, in 1936. In the fall after the burn, 250 screened and 250 unscreened spots, with 10 - 15 seed per spot, of each of ponderosa pine and Jeffrey pine were set out. Germination and first-year survival of the unscreened spots was relatively low compared to the screened spots (table 2).

Table 2.--Germination and survival in screened and unscreened seed spots sown at Burney Springs, 1936

Species	Germination		Survival	
	Screened	Unscreened	Screened	Unscreened
	Percent 1/		Percent 1/	
Ponderosa pine	69	31	59	15
Jeffrey pine	86	16	79	10

1/ Percent of seed spots with one or more seedlings.

Repellants

Attempts to prevent rodent damage by using materials supposedly possessing repellant qualities have been accompanied with varying success.5/ Toxic agents have been advocated as possible repellants on the hypothesis that if a rodent obtained a sub-lethal dose, it might subsequently avoid the seed. This conjecture has not been supported by seeding trials.

In the Big Springs plantation on the Lassen National Forest in 1935, 500 seed spots of ponderosa pine and of Jeffrey pine were set out with each of these treatments: (1) Seed not coated, spots not screened; (2) seed coated with a mixture containing strychnine, spots not screened; and (3) seeds coated and spots protected. Germination in the unscreened seed spots, with seed coated or uncoated, was less than 1 percent. Germination in the screened seed spots, with seeds coated was: ponderosa pine 39 percent, Jeffrey pine 42 percent.

In a seeding trial at Burgess Springs, Lassen National Forest, in October 1935, ponderosa and Jeffrey pine seed was planted with a corn planter at the rate 1 to 3 seeds per spot. The seeds were coated with a mixture of strychnine, plaster of Paris, and gum arabic. Seedlings were found in 9.3 percent of the ponderosa spots, about 29,000 in number, and 9.8 percent of a like number of Jeffrey pine spots. A germination test of the seeds so coated showed rates of 50 percent and 68 percent, respectively.

5/ Huberman, M. A. op. cit.

In the spring of 1950, on the Stanislaus Experimentsl Forest, stratified sugar pine seed was coated with "1080" carried in a latex base and rolled in precipitated chalk. Five coated seeds were sown in each of 240 unscreened spots. Five untreated seeds were sown in each of 240 unscreened spots and 240 screened spots. Seedlings germinated in 4 percent of the treated, unscreened spots, 10 percent of the untreated, unscreened, and 80 percent of the untreated, screened spots. Either the rodents did not ingest sufficient toxic material from the seed coats or the rodent population was large enough that rodent losses did not affect the extent of the depredations. Coating of the seed did not affect germination, according to a greenhouse test in which 64 percent of the coated seed and 65 percent of the uncoated seed germinated.

Pelleted Seed

Two small trials were made with ponderosa pine seed enclosed in a commercial pellet material containing a supposed rodent repellant. In one test no seed germinated out of several hundred seed planted in an old cut-over area. In the other test no seed germinated in 20 spots with 5 pelleted seed per spot while seedlings were found in 65 percent of another 20 spots of pelleted seed protected by screens.

Mechanical Protection

From the foregoing discussion it is obvious that, except in the Anderson Valley trial, success in seed spotting was obtained only when the spots were protected by screens. Germination and survival in the screened spots was consistently higher than that in the unscreened spots, regardless of the treatment of the latter.

Seedbed Conditions

Mineral soil or the ash-covered surfaces following fire appear about equally good as receptive surfaces for direct seeding. In a test of site preparation at Burney Springs in the spring of 1937, 900 seed spots of ponderosa pine and of Jeffrey pine were set out in each of these conditions: (1) Stripped brush, (2) burned brush, and (3) burned and stripped brush. Stratified seed was sown in these screened spots. The seedbed condition, either mineral soil, ash, or a mixture, had no appreciable effect on the germination, judging from the percent of seed spots in which one or more seedlings germinated:

Seedbed conditions	Ponderosa pine	Jeffrey pine
	- - - Percent - - -	
Stripped	92	95
Burned	89	92
Burned and stripped	91	91

Survival (one or more seedlings per spot) of the two species combined, at the end of the second year, was 75, 81, and 84 percent for the stripped, burned, and burned and stripped, respectively. Inasmuch as competition as well as surface condition may have affected survival, the differences in survival cannot be ascribed to surface condition.

In a 1940 test of seed spotting on mineral soil and on conifer and brush litter, germination, based on the total number of seedlings found, was as follows:

Species	Mineral soil	Litter
	- - - Percent - - -	
Ponderosa pine	53	28
Sugar pine	70	54
Incense cedar	32	21
White fir	21	18

There were 120 seed spots, with 15 seed each, of each species in each seedbed condition. The difference in rate of germination between conditions is statistically significant. Seedbed condition had little effect on the germination rate of white fir, as indicated by a statistically significant species-treatment interaction.

The first-year survival of sugar pine seed spots on large burned slash piles with a heavy ash layer was 53 percent (one or more seedlings per spot), compared to 59 percent on adjacent mineral soil. These observations were made on the Stanislaus Experimental Forest in 1950.

Seed Treatment

Sowing seed in spring may reduce rodent damage because the period of exposure of the seed to rodents is shortened appreciably. However, sugar pine seed must be stratified if sown in the spring. Ponderosa and Jeffrey pine germinate more promptly if stratified prior to spring sowing. Although direct comparisons of the use of stratified and unstratified seed have not been made, some of the results of seeding with stratified seed may be of interest. In the Burney Springs experiment 5,400 screened seed spots were sown in the spring of 1937 with stratified ponderosa and Jeffrey pine seed. Seedlings were found in 92 percent of the spots. In the same plantation seedlings germinated in 77 percent of 500 screened spots sown in the fall of 1936 and in 81 percent of 5,400 screened spots sown in the fall of 1937. The seed in these fall-sown spots was not stratified prior to sowing.

In the spring of 1950, stratified sugar pine seed was sown in 946 screened spots on the Stanislaus Experimental Forest. At the end of the first year 76 percent of the spots had one or more surviving seedlings.

During the stratification process, seed often becomes moldy. In an effort to prevent the development of the mold[6] and perhaps increase germination, sugar pine seed was dusted with an organic mercury fungicide prior to stratification. The treatment had no effect on germination. Seedlings were found in 55 percent of the spots with treated seed and in 58 percent of the spots with untreated seed. Either the fungicide was not effective or the specific unidentified molds were not pathogenic to sugar pine seed.

Relative Effectiveness of Seeding and Planting

Seed spotting has been about as effective as planting when the seed spots were protected from rodents, judging from second-year survival in several tests (table 3). In the spring 1937 test at the Burney Springs brushfield plantation, survival of ponderosa and Jeffrey pine screened seed spots was practically as high as the survival of the planted stock (1-1 ponderosa and Jeffrey pine). Survival of both seed spots and planted trees was very low in the fall test in the same plantation, but seed-spot survival was equal to that of planted stock. Survival of screened spots in the Anderson burn was as good as that of planted stock. Even unscreened spots had satisfactory survival in this burn where rodent damage had been low. In a test in the Stanislaus Experimental Forest in 1934, screened seed spots of ponderosa pine were as effective as planted stock. The survival of sugar pine spots was more than five times greater than the survival of the planted sugar pine stock. In a test in 1941 the proportion of screened seed spots of sugar pine with one or more seedling was a little higher than the survival percent of planted 1-1 sugar pine stock.

6/ Schubert has observed that infection of seed with Cylindrocarpon sp. caused poorer germination. Schubert, G. H. 1950. Viability losses of sugar pine (Pinus lambertiana, Dougl.) seed infected with certain fungi. M.S. thesis filed in the library of the University of California.

Table 3.--Second-year survival of seed spots and planted stock in certain tests where comparisons are possible

Location, year, and species	Seed spots		Planted stock	Basis
	Screened	Unscreened		
	- - - Percent - - -		Percent	
Burney Springs, 1937, spring; Ponderosa and Jeffrey pine	80	-	86	5,400 seed spots 5,400 planted trees
Burney Springs, 1937, fall; Ponderosa and Jeffrey pine	15	-	15	5,400 seed spots 5,400 planted trees
Stanislaus, 1934;				
Ponderosa pine	43	5	44	2,725 seed spots
Sugar pine	46	3	8	2,975 planted trees
Anderson burn, 1934,				2,000 seed spots
Ponderosa pine	76	64	74	2,400 planted trees
Stanislaus, 1941;				592 seed spots
Sugar pine	50	-	41	592 planted trees

Summary and Discussion

In a series of seed-spotting tests conducted over a period of years, depredations of forest rodents were the chief obstacle to successful direct seeding. Screening of the seed spots was the only consistently effective means of protecting the seed from rodents. At present, the high cost of fabrication and use of the conical screens used in the tests prohibits their general adoption. The dome-shaped screens designed and found successful by Keyes and Smith[7] are much cheaper to produce but must be removed no later than the second year. Currently an inexpensive, expendable screen,[8] which may not need to be removed, is being tested extensively in the hope that this screen will make direct seeding feasible. A current study of the habits of forest rodents by biologists of the University of California may yield clues leading to more effective use of poisons or repellants. Until the problem of protecting seed from rodents is solved, direct seeding cannot be recommended as a practical means of regeneration.

Given adequate rodent protection, however, seed spotting was found to be a satisfactory method of regeneration, compared to planting, on burned surfaces and on mineral surfaces with fall-sown seed or spring-sown stratified seed.

7/ Keyes, Joseph and C. F. Smith. 1943. Pine seed-spot protection with screens in California. Jour. Forestry 41: 259-264.

8/ Designed by Mr. Joseph Keyes.